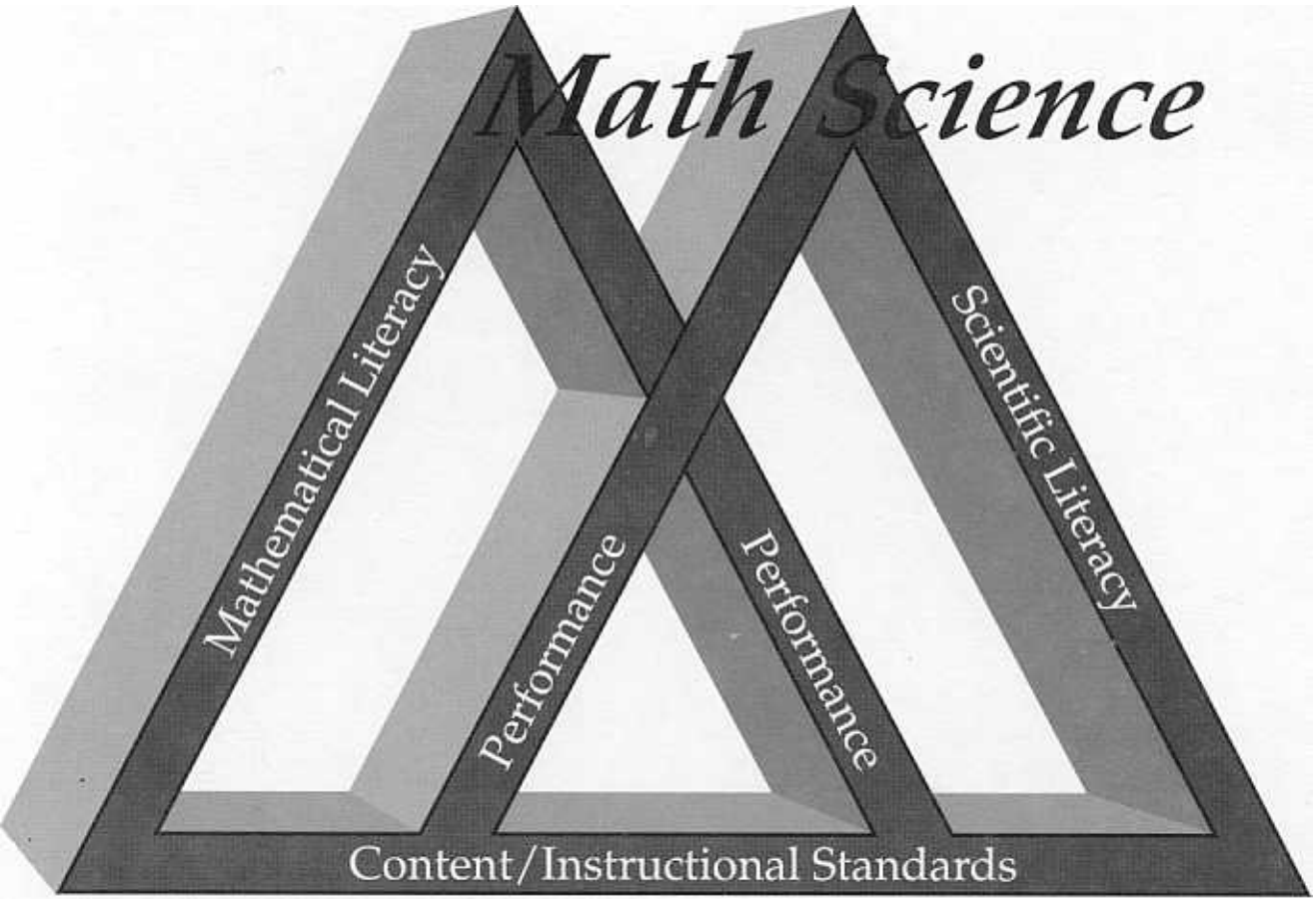
Mathematics & Science Frameworks

for Nebraska Schools



Kindergarten through Grade Twelve

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Adopted by the Nebraska State Board of Education March 6, 1994

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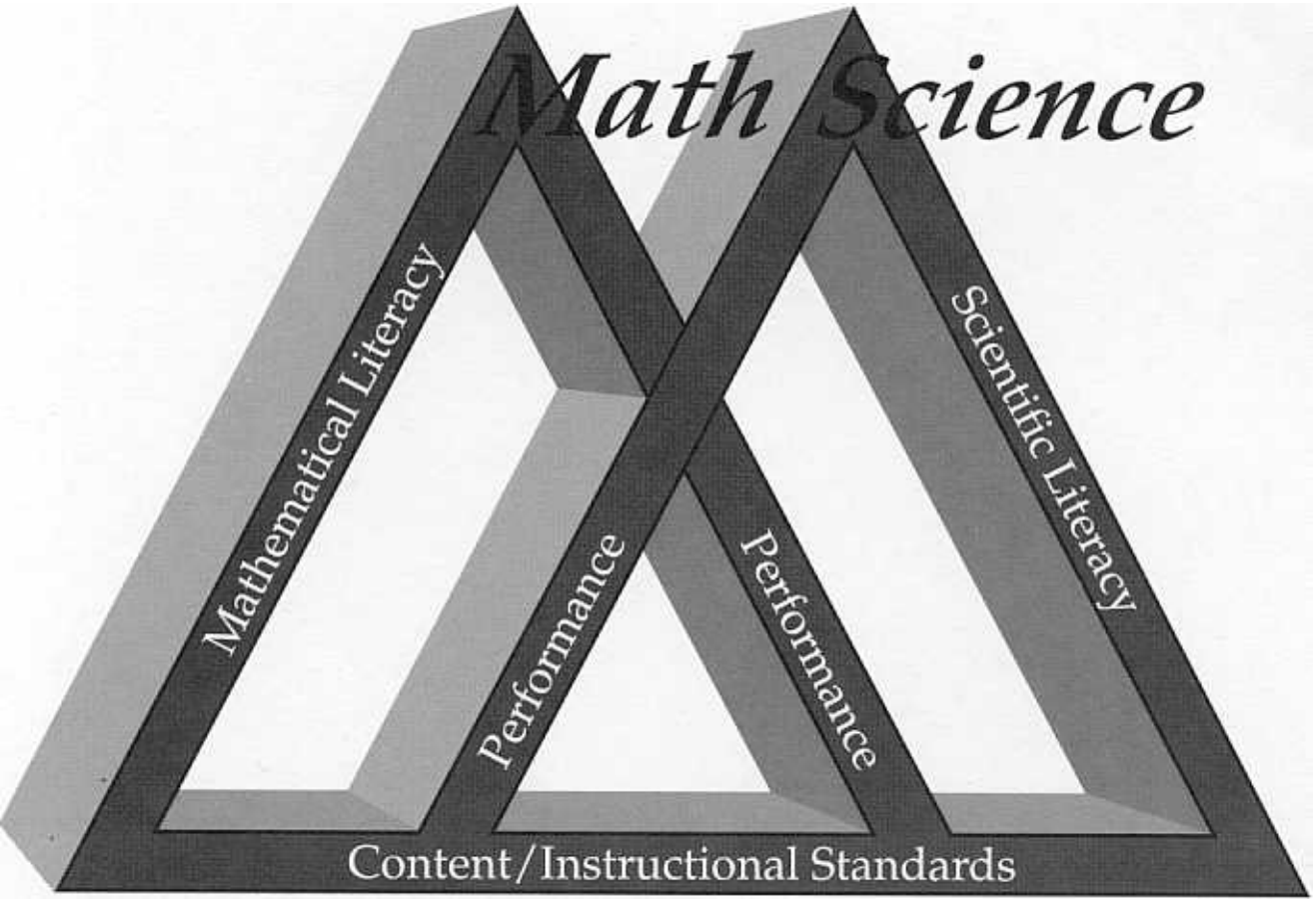

Kindergarten through Grade Twelve

FOREWORD

The national effort to develop standards is a historic change in the American educational system. In 1989 the nation's fifty governors adopted the National Education Goals. These goals are the basis of the Goals 2000: Educate America act, a plan developed by President Clinton to meet the goals established by the Governors' Panel. The national standards were developed to help state and local educators focus on providing the opportunity for all students to learn at high levels.

These voluntary national standards will determine what all students should know and be able to do to live and work in the 21st century. The national standards describe the knowledge, skills, and understanding that students should have to reach National Education Goal #4, which states, "By the year 2000, U.S. students will be first in the world in mathematics and science achievement."

The national reform efforts are advocating mathematics and science for all students. Providing challenging opportunities to learn mathematics and science for all students, regardless of race, gender, ethnicity, economic status, or physical and intellectual development, requires utilization of diverse teaching strategies. A variety of strategies helps teachers to accommodate the learning styles of all students and to encourage students to construct their own understanding of mathematical and scientific concepts.

If the goal of enhancing learning for all students is to be reached, effective teaching should reflect the nature of mathematics and science and current findings about how students learn mathematics and science. In the past, the focus of education was on what the teacher did - educators focused on teaching behavior planned around specified goals and objectives. They made assumptions about appropriateness of curriculum materials and students' prior knowledge. Now the focus of education is on what the student does. Educators plan varied experiences centered around the learning needs of individual students. In the new view of education, the learner's characteristics and needs guide curriculum planning and affect both the learning environment and the teacher's role in facilitating the learning process.

The national reform efforts and the Nebraska Mathematics/Science Frameworks encourage the development of conceptual relationships and encourage the students to construct meaning for themselves. The emphasis is on creating knowledge, skills, and understandings.

The existence of national standards has made it easier to determine what educators need to do to help students to think and to solve problems in today's competitive economy. The Nebraska Mathematics/Science Frameworks document provides the needed guidelines to meet the challenge of Goals 2000: Educate America for developing world-class mathematics and science programs.

Sincerely,

JOE E. LUTJEHARMS, Ed.D.
Commissioner of Education

NEBRASKA DEPARTMENT OF EDUCATION

301 Centennial Mall South • P.O. Box 94987
Lincoln, Nebraska 68509-4987
Telephone (402) 471-2465 • Fax (402) 471-4433

May 1, 1994

Dear Colleagues:

The Department of Education is committed to the principle of providing quality education for all students. Our commitment is expressed in the High Performance Learning Model, a model that offers guidance to local school districts as they plan and implement school improvement activities including the redesign of their curriculum. The High Performance Learning Model identifies essential areas which school districts may consider in the school improvement plans.

High Performance Learning requires quality curriculum and instructional programs and practices. Curriculum frameworks are essential strategies for designing quality curriculum and the instructional programs and practices necessary for quality teaching and learning. The Department intends for curriculum frameworks to be used as tools for schools to use in examining current curriculum, determining important revisions, and for considering the implementation of national standards such as those of the national organizations for mathematics and science. This framework for math and science identifies the content knowledge and skills and does so in a way to provide direction, focus and coordination of K-12 mathematics and science curriculum without being prescriptive. This framework is not a curriculum; it is a guide for local decision-making.

This framework provides for vertical and horizontal coordination of mathematics and science curricula, encourages connections between math and science and other subject areas, and advocates active student participation by encouraging exploration of real life issues and use of activity-based learning experiences. The Mathematics/Science Framework is not mandated and is deliberately flexible to accommodate the needs and resources of individual school districts.

It is our hope that Nebraska Mathematics/Science Framework provides guidance and support to enhance learning for all students in the State of Nebraska and that it will be used as a resource for local curriculum planning.

Sincerely,

DOUG CHRISTENSEN, Ph.D.
Deputy Commissioner

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Numerous individuals representing teachers, teacher educators, learning psychologists, curriculum developers, subject-matter supervisors, school administrators, parents, and citizens have provided input to create a useful document for Nebraska.

Advisory Board

Members:

Deb Anders, NE Consortium for Improvement of Teacher Education
Helen Banzhaf, 1992-93, NE Association of Teachers of Mathematics
Keith Bartels, NE Association of School Boards
Mary Chochon, NE Association of Teachers of Mathematics
Odus Elliott, NE Coordinating Commission for Postsecondary Education
JoAnn Havlovic, Educational Service Unit
Gladys Helm, 1992-93, Educational Service Unit
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Davyd Morton, Business, Central States Health and Life Company of Omaha
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De Tonack, NE Math and Science Initiative
Jim Werth, NE Special Education Advisory Council

Liaison Members:

Ann Masters, NE Dept. of Education
Deb Romanek, Co-Director
Catherine Wilcoxson, Project Coordinator
Jim Woodland, Co-Director

Writing Team

Team Leaders:

Candy Connery, LaPlatte Elementary
Stephen Hamersky, Daniel J. Gross High School
Cynthia Heinrich, Juanita Public School
Michael Tolfa, North Loup Scotia High School
Lenny VerMaas, Norris Middle School
Caroline Winchester, Wolbach Public School

Team Members:

Beth Anderson, Brownell Talbot
Cindy Anderson, Emerson-Hubbard Elementary
Marge Badman, Tri County
Sharon Brenner, Valentine City School
Marilyn Browder, Franklin Learning Center
Rae Brown, Pender Elementary
Brenda Charles, St. Stanislaus
Sharon Cripps, Crawford Elementary
Patricia Crum, Aquinas Middle/High School
Thomas Epling, Grant High School
Carolyne Ewing, Gering Jr. High School
Darcie Girmus, Fairmont Public School
Shawnee Golka, Seward High School
Sally Harms, St. Francis Central High
Denise Hunzeker, Pawnee City School
Virgil King, Lexington City Schools
Nancy Kunkel, Hebron Primary
Sandra Meyer, Lexington Sr. High
Ken Morten, Randolph High School
Julia Polak, St. Joseph's School
Dot Snesrud, Osceola Elementary
Paul Sok, Winside Public Schools
Dianne Vorderstrasse, St. Paul Public School
John Walsh, Mockingbird School
Ann Wardle, Lakeview Elementary
Becky Welte, Walt Disney Elementary
Judith Williams, Central City High School

Editors

Gordon Culver, Alphagraphics, Deb Brown, Nancy Christ

Consultants

Harriet Egertson, Alice Foster, Sharon Katt, Betsy Kean, Toni Santmire

Mathematics/Science Frameworks Team

Winona Maxon, Asst. Project Coordinator
Susan Goodrich Shelbourn, Elementary Level Consultant
Niki Smith, Secretary
Deb Romanek, Project Co-Director
Lenny VerMaas, Middle Level Consultant
Catherine Wilcoxson, Project Coordinator
Jim Woodland, Project Co-Director

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Nebraska Math and Science Initiative
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Richard Simon
Peter Smith
JoAnn Smith
Nancy Smith
Sandi Snyder
Cathryn Snyder
Marla Soester
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Marsha Kay Stewart
Nina Straatmann
Judy Strate
Kent Sughroue
Robert Sweetland
Don Swigart
Bob Talbitzer
Laura Tegtmeier
Carl Thomas
Carolyn Thomas
Rosemary Thornton
Tammy Tillman
Deloy Titkemeier
Vicki Troxel
Cindy Troyer
Frank Tworek
Lee Van Der Werff
Lenny VerMaas
Roxy Voorhees
Dianne Vorderstrasse
Shirley Wach
Mary Wadsworth
Amy Wallman
Bill Wellner
Peg Welsch
Becky Welte
Kraig Weyrich
Jean Whitten
Dan Widick
Joyce Wieseler
Linda Wilkenson
Judith Williams
Roseanne Williby
John Wood
Janet Wright
Sharon Wuertz

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Donn Carlson, University of NE-Kearney
Joanne Carlson, College of St. Mary's
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Lois Coleman, Nebraska Wesleyan University
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Bob Egbert, University of NE-Lincoln
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Acknowledgments

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Roger Olson, Dana College
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Janice Rech, University of NE-Omaha
Robert Sweetland, Wayne State College
Mel Thornton, University of NE-Lincoln
George Veomett, University of NE-Lincoln
James Walter, University of NE-Lincoln
Rob Wikel, Doane College

AN EXPLANATION OF FRAMEWORKS

The Nebraska K-12 Mathematics/Science Framework project is designed to provide direction, focus, and coordination for best practices in mathematics and science instruction. The Frameworks is a resource for schools to improve the quality of instruction education for ALL students through the systemic change process. The Frameworks is not a mandate, rather, local districts may use the frameworks to determine and implement the concepts, ideas, and practices presented in the Frameworks. The readers of this document are being asked to reflect on reforming mathematics and science education in Nebraska and utilizing the Frameworks as a tool in this process.

The educators involved in preparing this document made connections within the disciplines of mathematics and science as well as across all disciplines. The mathematics and science sections complement each other through common skills and processes of learning, sample investigations, and models. Practicing teachers are encouraged to carry out these connections as these connections enable all students to develop meaning and reality of mathematics and science.

Frameworks is a three year, multifaceted project. This document developed, in the first year, provides guidelines for the development of models and performance assessments which will be designed during the second and third year. In addition, Frameworks can provide the focus for preservice teacher education programs.

The opening section of the document discusses the changes presently influencing and impacting mathematics and science education. The elements of change addressed include: mathematics and science literacy for all students, appropriate learning environments, relevancy, role of technology and models, and the skills and processes of learning. The Frameworks are based on nationally recognized standards in mathematics and science.

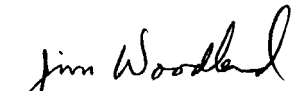
Ensuing chapters address mathematics and science content. Multi-age groupings provide flexibility to achieve the measurable performances. The use of multi-age groupings assumes that there will be continuous learning within each group and between groups. Each grade group begins with an overview or definition of the content. This is followed by measurable performances which provide guidance to teachers as they progress toward a process oriented teaching style. Sample investigations are included to exemplify how students might demonstrate the measurable performances and to connect the subject matter to real life experiences. The appendix provides contact information concerning state and national professional organizations and access to electronic networking.

The framework project is not enough to complete systematic mathematics/science reform. The critical factor in reform is committed teachers. Teachers need support in the form of partnerships, instructional materials, and time. Teachers will need ongoing commitment from their colleagues, administrators and community to make mathematics and science a reality for all students.

Ann Masters
Curriculum &
Instruction Administrator

Deb Romanek
Co-Director

Catherine Wilcoxson
Project Coordinator



Jim Woodland
Co-Director

Mission Statement

The mission of the Mathematics/Science Framework is to provide guidance and support to enhance learning for all students in the state of Nebraska.

Beliefs

All students can learn science and mathematics, given support and opportunity.

All students can appreciate mathematics and science.

Science and mathematics are an integral part of everyday life.

Learning mathematics and science requires active participation.

Learning is a collaborative responsibility among students, educators, parents, and the community.

Science and mathematics instruction must be relevant, student oriented, and process driven to accommodate the needs of a changing world.

Connections must be made within mathematics and within science as well as across all disciplines.

Learners must be empowered to think and learn for themselves.

Performance Goals

The Mathematics/Science learner will:

- Use problem-solving skills to make informed decisions;
- Work cooperatively and independently;
- Communicate effectively to a variety of audiences;
- Apply appropriate process skills to real situations; and,
- Demonstrate mathematical and scientific literacy in a global environment.

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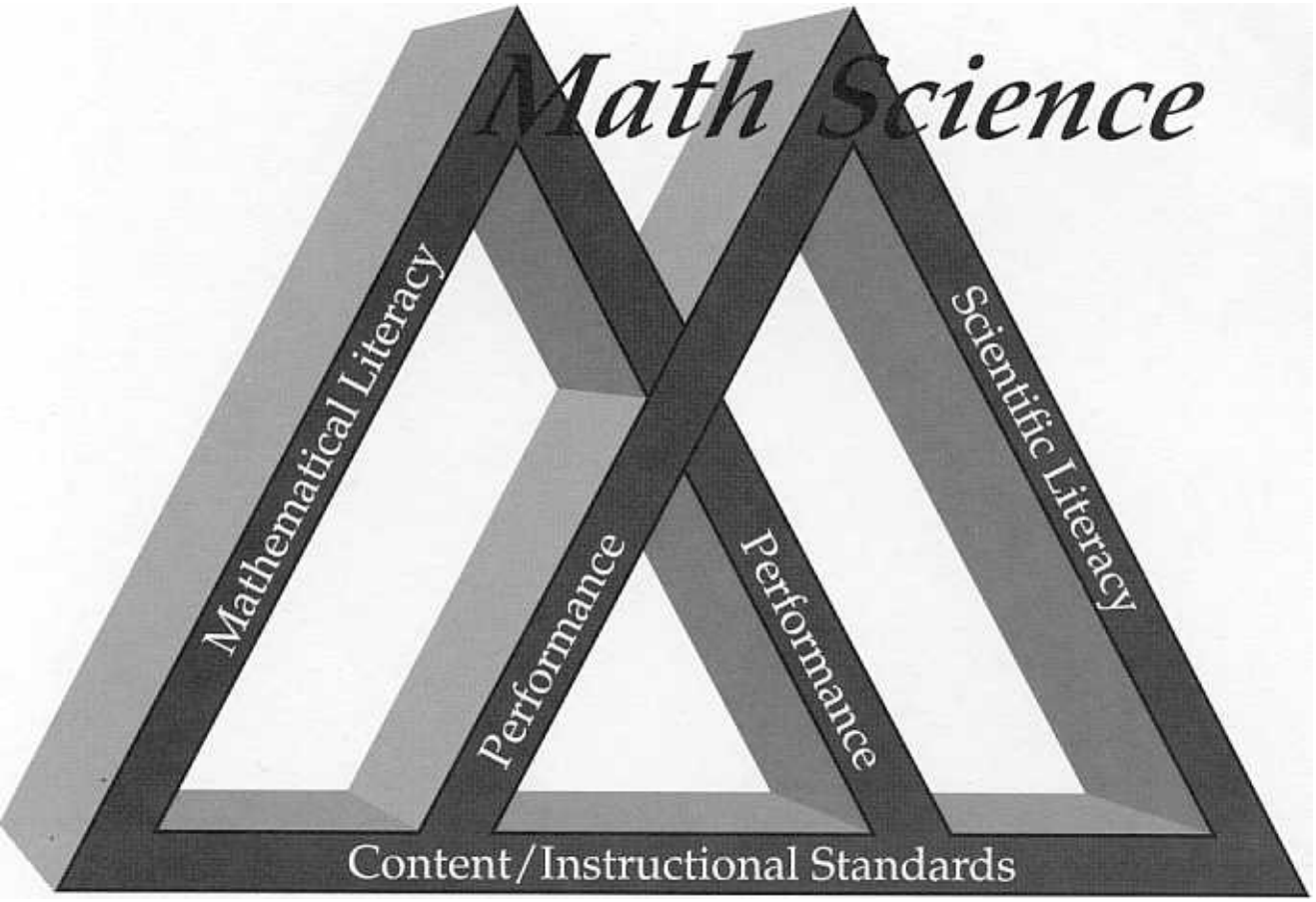


Kindergarten through Grade Twelve

Introduction to Mathematics & Science Frameworks

Need for Change in Mathematics/Science Education

Typical midwestern values placed on education and hard work, well prepared and dedicated teachers, and a generally stable economy have combined to provide an atmosphere in which traditional approaches to education have served Nebraska well. In terms of achievement, Nebraska's students have consistently ranked among the top ten state populations in the nation. However, because we now live with an economy that is increasingly global in nature, what has been adequate in the past needs to be assessed and adjusted to effectively meet the current and future needs of our students.

Nebraskans pride themselves on the state's national testing results; however, the value of such rankings in over-all benefit to students is doubtful. Perhaps of greater significance is the fact that a majority of the state's high school graduates are continuing into some form of education, and this pattern is expected to continue and to increase in the future. Because of the increasing role of technology today's students must be equipped with the skills and knowledge that will permit them to enter an ever-changing job market.

All students need mathematics and science skills to live and be knowledgeable citizens in the 21st century. With technology influencing the lives of citizens so personally, mathematics and science concepts can no longer be for a select few; these concepts need to be developed and cultivated by all students throughout their educational programs. Teachers must provide opportunities for all students to relate mathematical and scientific concepts to their personal lives and set the pattern for applying those concepts in real-life situations after leaving the classroom.

Mathematics and Science Literacy for All Students

Mathematics/Science literacy for ALL students is a goal for the State of Nebraska. As indicated by the American Association for the Advancement of Science, scientific literacy — which encompasses mathematics and technology as well as the natural and social sciences — has many facets, including:

- *being familiar with the natural world and respecting its unity;*
- *being aware of some of the important ways in which mathematics, technology, and the sciences depend upon one another;*

- *understanding some of the key concepts and principles of science;*
- *having a capacity for scientific ways of thinking;*
- *knowing that science, mathematics, and technology are human enterprises, and knowing what that implies about their strengths and limitations; and*
- *being able to use scientific knowledge and ways of thinking for personal and social purposes.*

The first phase of the Nebraska Mathematics/Science Frameworks project has established a conceptual base for mathematics/science reform by identifying the knowledge, skills and processes of learning that all students should acquire by the time they finish secondary education in the State of Nebraska.

The underlying principle that ALL students can learn mathematics and science is central to the successful implementation of Nebraska Mathematics/Science Frameworks. This principle recognizes the increasingly diverse nature of Nebraska's student population and the wide range of intellectual abilities, learning styles and cultural experiences represented in that population. The principle also places squarely upon mathematics and science teachers of the state the need to identify multiple teaching strategies and become proficient in their implementation to enable ALL students to learn mathematics and science successfully.

The disciplines of mathematics and science are rich with possibilities for developing hands-on and inquiry-based instruction in order that learning by students of all abilities, learning styles, races and gender might be enhanced. Mathematics and science classrooms also provide excellent environments in which students can develop the attitudes of integrity, open-mindedness, objectivity, and self-esteem so important to function successfully in a multicultural society.

Finally, history helps students understand the processes of science and mathematics and the development of a "modern" scientific method. The scientific method functions as a framework for the development of ideas. The database for mathematics and science is expanding daily; the rate at which new information accumulates is astounding. While in the mathematics/science classroom, students need to learn how to respond to new information and how to assimilate such information for their personal well-being.

Learning Environment

Nebraskans need to provide appropriate guidance and support that will enhance learning in K-12 mathematics and science throughout the state. Such an environment will:

- *support and encourage active learning through concrete and continuous interactions with the real world, including activities outside the classroom;*
- *foster a positive disposition towards mathematics and science for ALL;*
- *encourage mutual respect by students for differing points of view and for each other; and*
- *provide an instructional setting in which students feel safe to learn*
  - *safe to explore issues and express opinions and*
  - *safe from physical harm from the instructional equipment and materials.*

Role of the Student

Students should be actively involved in and responsible for their learning. They should be placed in learning environments which will encourage the development of good listening skills, a respect for different viewpoints, and a tolerance for reasoning and sharing ideas with each other. Students need to develop and use their abilities to look for mathematical and scientific evidence in resolving problems, to make conjectures, and then to support their solution. To become mathematically and scientifically literate, students must be able to apply mathematics and science to their everyday lives.

Role of the Teacher

The primary responsibility for revitalizing school mathematics and science rests in the educational community with the school as the primary delivery agent. Teachers are powerful influences to the students and to the community. Teachers need to model active learning by presenting themselves as seekers and problem solvers willing to struggle with new problems and challenges, not always knowing the answer or outcome. They need to establish environments that:

- *facilitate students' learning of mathematics and science;*
- *increase the levels of student participation;*
- *promote connections to other disciplines and to real-world events; and*
- *provide opportunities for students to improve their self-esteem.*

Teachers need to provide time for students to grapple with problems, search for strategies and solutions, and consider the implications and outcomes of their decisions. Assessment tools that develop reasoning skills in all students should be utilized. A teacher must become actively engaged in issues of teaching and learning, have an ongoing commitment to professional growth, and assume a leadership role in working with administrators to implement a mathematics and science curriculum for all students based on national standards.

Role of the Policy Maker

Administrators and school board members have a responsibility to understand the goals of mathematics and science education in the public schools; this understanding is essential if they are to accurately interpret mathematics and science programs to parents and to the community in general. Teacher involvement is crucial to the policy-making process; administrators should look to teachers for guidance and recommendations in such matters as determining what constitutes quality mathematics and science programs, how resources are to be allocated and used, and what performance outcomes are to be expected of students.

As policy makers, administrators and school board members should support the national, state, and local educational standards by implementing programs that are consistent with those standards. Teachers need opportunities to share ideas, plan interdisciplinary learning situations, explore instructional strategies, and take advantage of professional-development opportunities. This requires commitment of time, resources, equipment, and funding. Policy makers are aware and supportive of these needs by teachers; they recognize that a school's instructional efforts are enhanced by a teaching staff that continues to learn and to improve student programs.

Role of the Community

A community has a vested interest in its schools; the community provides the financial base that makes the educational program possible. Educational institutions reflect the interests, values, aspirations, economic and political beliefs of the citizens in the community; consequently, all aspects of the community should be actively involved with coalitions working to improve the learning climate in the schools. Quality mathematics and science programs depend upon the community to provide the resources needed to meet the educational needs of all students. Educators need to communicate to parents and to all members of the community information about the specific needs of the mathematics and science curricula and the budgetary requirements needed to support such programs. The community should also support the programs in ways other than monetary:

- *by providing tutorial and mentorship programs;*
- *by recognizing and encouraging students' academic achievements;*
- *by encouraging parental involvement; and*
- *by providing positive role models for all students.*

Working together, members of a community can provide an educational system that has the community's support for the learning goals and performance outcomes of the mathematics and science curriculum; in arriving at this support, the community should gain an appreciation for the many ways mathematics and science affect and influence students' lives.

Role of Technology

In today's world, business and industry are demanding workers who can use current technology and are capable of learning and applying new technology These requirements will be even more critical for workers in the 21st century

The American Association for the Advancement of Science describes technology as follows:

> Technology — like language, ritual values, commerce, and the arts — is an intrinsic part of a cultural systems and it both shapes and reflects the systems values. (1989, p. 23)

Students in the mathematics/science curriculum should have available various technological tools that aid in data collection, data analysis, research, telecomputing, reporting, and presenting. Technology allows all students to explore topics in spite of differences in skill level or special needs. All learners can successfully complete significant tasks that would be difficult or impossible without the use of technology.

The National Science Teachers Association and the National Council of Teachers of Mathematics recommend the integration of calculators and computers in learning science and mathematics. Calculators should be available at all times with an added emphasis on estimation of results and multiple methods. Computers should include necessary software and connections to district, regional, and global networks if maximum benefits are to be derived from their use. Community coalitions should be developed and cultivated to support and train teachers and students in the use of new technology.

Connections: An Interdisciplinary Approach

Today's real-world problems are complex, and their comprehension and solutions require knowledge and integration of several subject areas. In order for students to become responsible citizens who are able to make informed decisions, they must see the relevance of what they are learning and the possibilities for transferring what they are learning to a variety of real-life situations. Emphasis should be given to conceptual understanding and application of mathematical and scientific knowledge and skills. Student-centered learning involves, among other things, that students investigate, explore, discuss ideas, develop conjectures, and test hypotheses. Instructional programs which integrate curricula provide time to explore topics in greater depth and to focus on developing conceptual understandings rather than the memorization of a massive amount of terminology and facts.

Students are naturally curious about the world around them. The mathematics and science frameworks provide a continuum that facilitates and encourages the integration of content with other areas of the curriculum; this continuum also encourages a developmental mode for presenting subject matter throughout the K-12 program. As students progress through the curriculum--from elementary through the middle level and into high school, the mathematics and science subject matter becomes progressively more complex; accordingly, learning strategies can be selected that are appropriate for the developmental level of the students. Throughout this continuum, teachers should be alert for opportunities to integrate mathematics and science with other content areas in the curriculum

K-12 Developmentally Appropriate Practices

The intent of these Mathematics and Science Frameworks is to provide guidance to Nebraska's public and private school districts to improve the quality of education for all students. The resulting programs should develop the skills of logical, deductive reasoning and delineate the content knowledge which all students should learn. Today's global society, the variety of future challenges and the rapid increase in the Mathematics/Science knowledge base necessitates an emphasis on conceptual understanding and real-life problem solving.

Children and adults do not think the same way. The process of development grows in a predictable way during the years between kindergarten and the end of high school. The developmentally appropriate classroom teacher views the child as continually developing and provides the environment in which every child can interact in ways that are meaningful to that child at that time. Students construct their ability to reason through their experience with the world around them (Piaget, 1976, Vygotsky, 1986). The nature of the

information they acquire and the skill with which they apply that information in solving problems reflects their added maturity and greater knowledge base.

Mathematics/science teachers can enhance their instructional efforts by recognizing that children learn differently throughout their lives. Teachers should make a concerted effort to see that learning goals and instructional strategies are appropriate for their students. For example, during the primary years, children construct the meaning of concepts through the process of experiencing disequilibrium. An important consideration is that the child must have active experiences in order to construct meanings. Teachers should not equate age and grade level with individual development. The individual differences of all students must be recognized and addressed by the teacher. The developmentally appropriate classroom teacher responds to the child's development by providing the resources necessary for the development of conceptual understandings.

Some characteristics of developmentally appropriate classrooms are:

- *The environment is designed to provide opportunities to construct integrated systems of different subject areas, thus developing students thinking skills.*
- *The environment is structured to accommodate students who enter the mathematics/science classroom with different levels of understanding and different degrees of skill development.*

Mathematics/Science Process Skills of Learning

The learning of science and mathematics involves continually examining phenomena and assessing whether current explanations adequately encompass these phenomena. The following process skills of learning are common to both mathematics and science and promote connections between the two.

Classifying: Grouping or putting in order collections of objects or events based on observable characteristics.

Communicating: Conveying information by using oral and written words, nonverbal signals, diagrams, maps, graphs, and visual demonstrations.

Connecting: Establishing relationships within subject areas or with real world happenings.

Hypothesizing: Forming a generalized statement which attempts to explain observations or inferences.

Inferring: Interpretating or explaining given facts or evidence.

Interpreting Data: Making inferences, predictions, hypotheses or conclusions from collected data and checking for reasonableness of solutions.

Measuring: Using instruments to determine quantitative properties of objects, systems, or phenomena under observation. Also the ability to carry out calculations with those instruments.

Modeling: Forming mental "pictures" which are developed to explain observations and make predictions.

Observing: Using the five senses of sight, touch, smell, sound and taste to obtain information about objects or events.

Patterning: Discovering repetitive similarities.

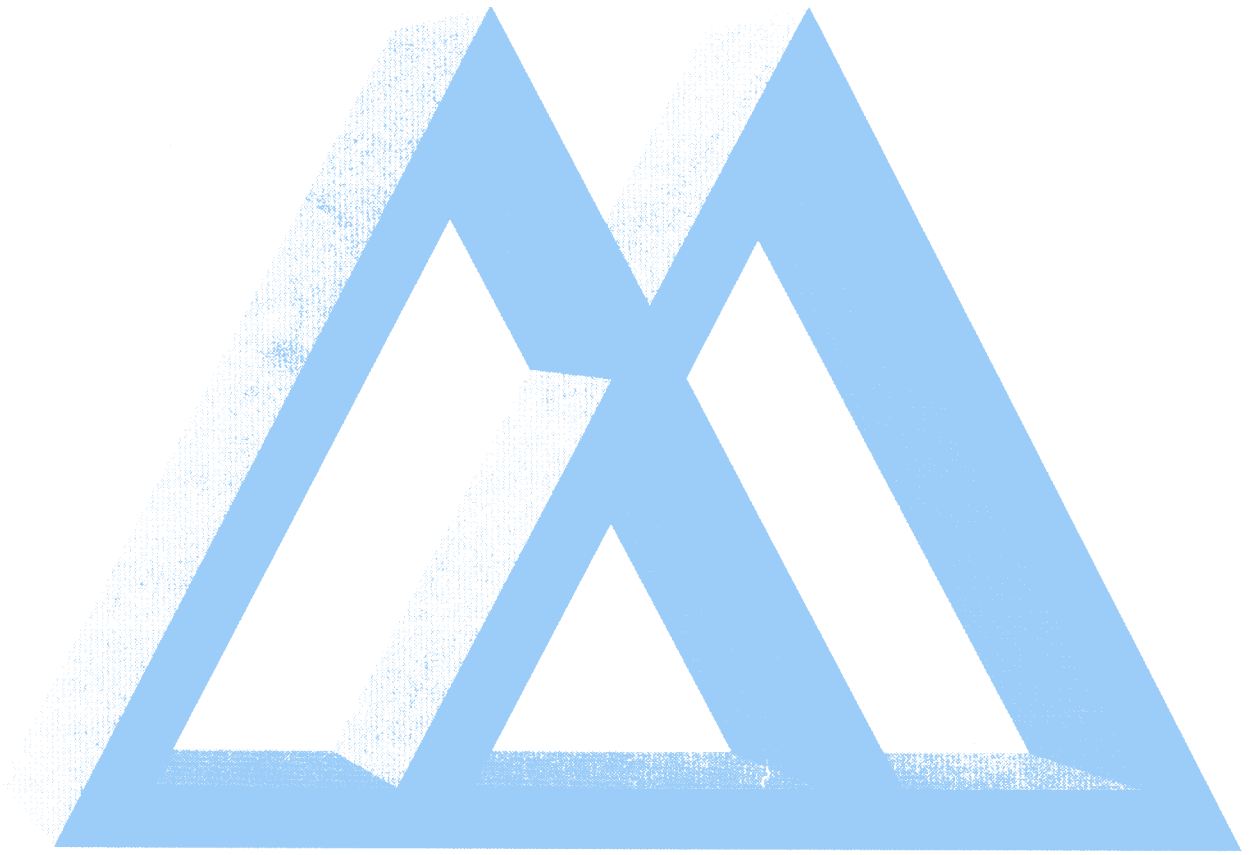
Problem Solving: Using all of the process skills.

Predicting: Making a specific forecast of what a future observation will be. It is based on past observation and inference.

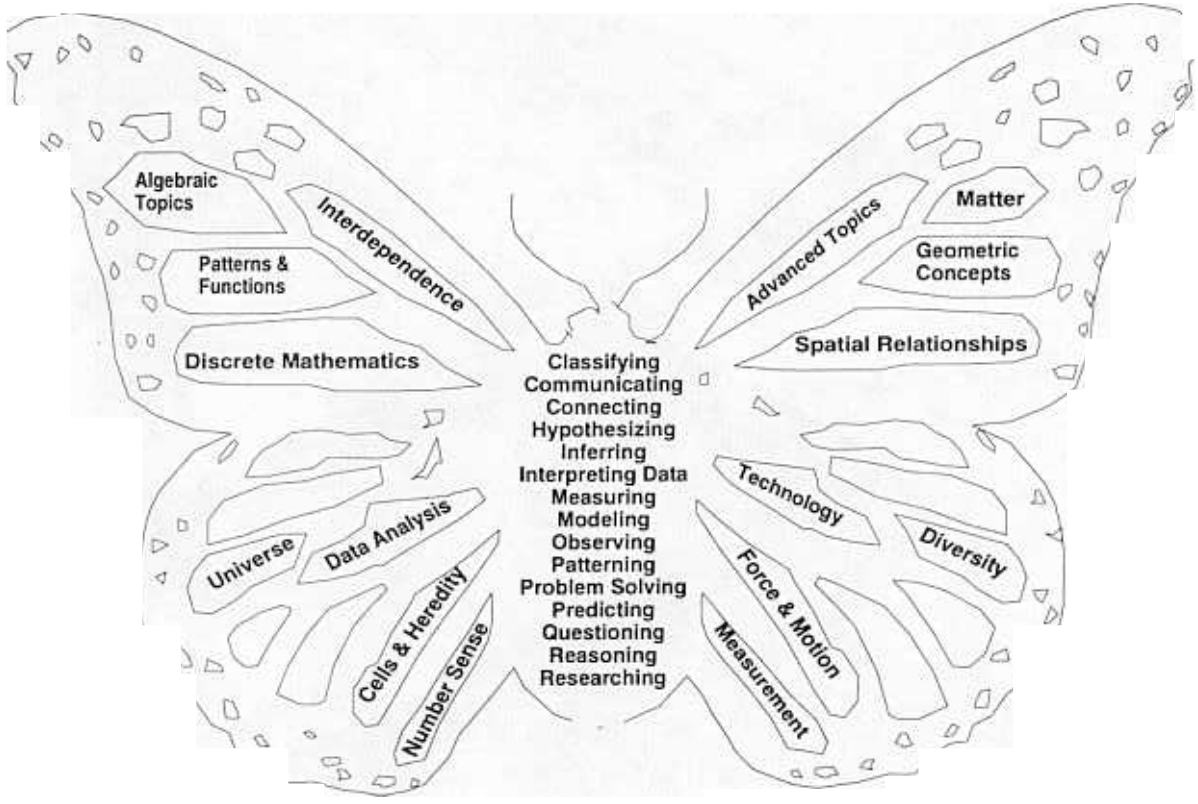
Questioning: Inquiring and searching for pertinent information.

Reasoning: Forming a generalized statement which attempts to explain observations or inferences.

Researching: Accessing and interpreting information which may involve the ability to control variables and to determine possible relationships.



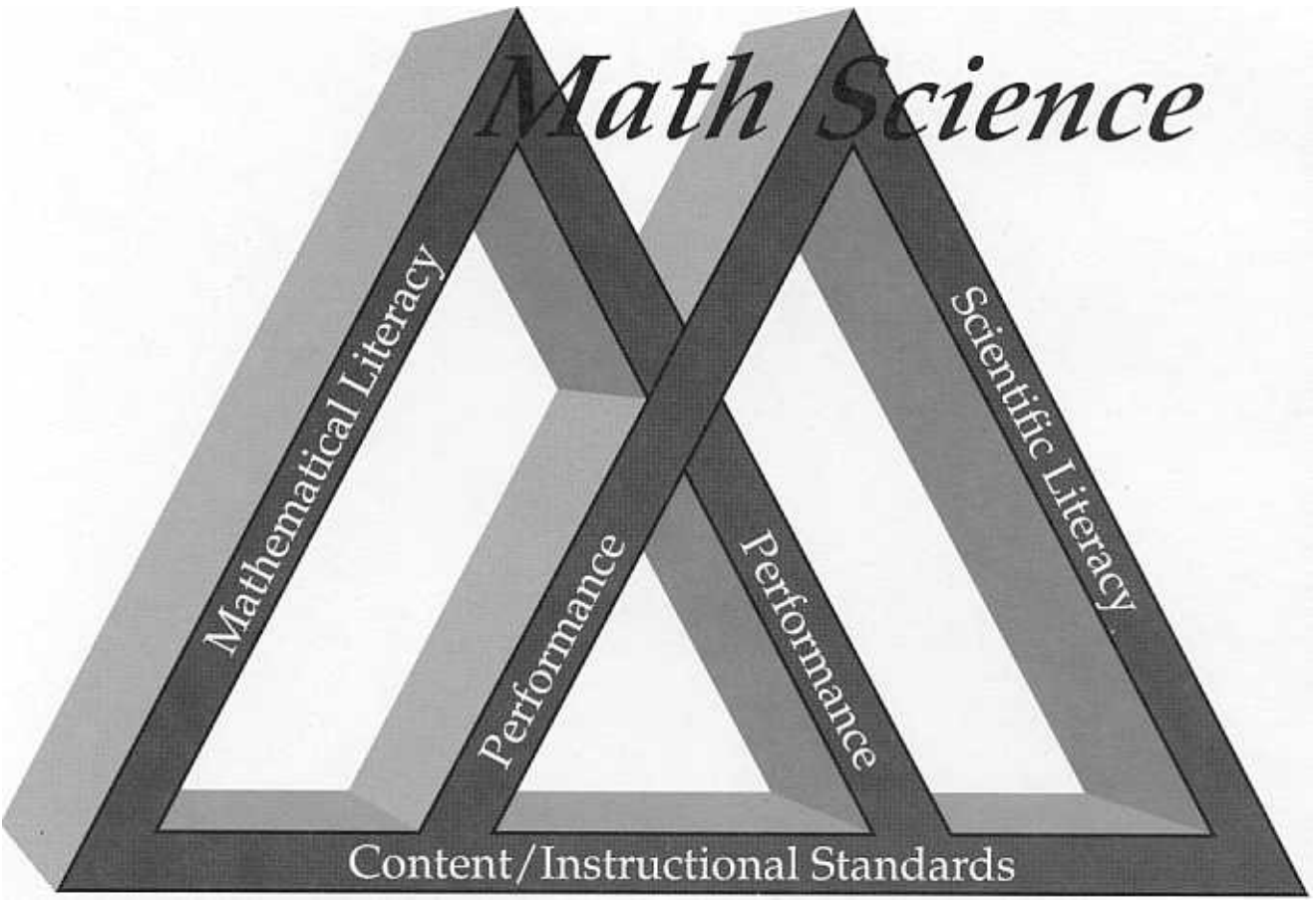
Mathematics/Science Process Skills of Learning



The beauty and symmetry of the butterfly reflects the beauty and symmetry between mathematics and science and their connections with nature. This allows freedom to view the world from different perspectives and migrate to new thoughts.

As a butterfly undergoes metamorphosis it is the hope of the writers and reviewers of this document, that these frameworks too will undergo metamorphosis and continue to evolve. Therefore, empty spots remain on the wings.

Mathematics & Science Frameworks
for Nebraska Schools



Mathematics

Kindergarten through Grade Twelve

OVERVIEW OF K- 2 MATHEMATICS

TOPIC STRANDS	CONCEPTUAL THREADS						
	LEVEL	ESTIMATION	PROBLEM SOLVING	TECHNOLOGY	COMMUNICATION	CONNECTIONS	REASONING / LOGIC
NUMBER SENSE	Elementary	Apply estimation to computation	Apply problem-solving processes	Use calculators, computers, and other technology	Discuss number system Describe and evaluate number relationships such as fractions, decimals, and percentages	Explore real-life situations	Justify a solution
	Middle Level	Verify and apply number properties (commutative, associative, and distributive)	Explore proportional relationships to solve problems Record shortcuts and hints for problem solving	Use technology to explore scientific notation, exponents, and order of operation	Describe, evaluate, and record relationships between various numerical representations	Use appropriate numerical representations and symbols for information gathered from all disciplines	Explore absolute val order of operations, and number properties

TOPIC STRANDS	CONCEPTUAL THREADS						
	LEVEL	ESTIMATION	PROBLEM SOLVING	TECHNOLOGY	COMMUNICATION	CONNECTIONS	REASONING / LOGIC
MEASUREMENT	Elementary	Compare and describe measurements Estimate measure of mass, length, volume, and time Choose appropriate units	Explore measurement in real-life situations	Select and use appropriate tools	Express measurement in a variety of units	Use measurement in other disciplines	Observe attributes using a variety of units Justify chosen unit of measurement
	Middle Level	Analyze precision in measurement Estimate measure of angles, line segments, and curved surfaces Choose appropriate units	Create concrete models as a tool to solve problems	Select and use appropriate tools Investigate the effects of measurement changes using technology	Present various methods of solving measurement problems using standard and nonstandard units of measurement	Demonstrate mapping skills Investigate historical use of measurement Select and use appropriate units to measure quantities in other disciplines	Justify chosen unit of measurement
	Secondary	Apply magnitude sense and practical "rules of thumb" Choose appropriate units	Utilize scale models and diagrams Explore real-life situations	Justify selection of measuring tools using precision Use software for measurement to facilitate other learning	Think in units without conversions Describe measurement process and result	Use appropriate measurement units from other disciplines	Use measurement as a tool to validate conclusions

TOPIC STRANDS	CONCEPTUAL THREADS						
	LEVEL	ESTIMATION	PROBLEM SOLVING	TECHNOLOGY	COMMUNICATION	CONNECTIONS	REASONING / LOGIC
SPATIAL RELATIONSHIPS /GEOMETRIC TOPICS	Elementary	Predict properties of shapes	Solve problems using shapes and diagrams Apply perimeter, area, and circumference Explore volume and surface area	Explore geometric shapes and solve geometric problems using a variety of technology	Identify properties and use appropriate geometric vocabulary	Explore geometric shapes in the world	Investigate changes of shapes
	Middle Level	Predict and compare properties of geometric models Estimate square roots Estimate perimeter, area, and volume	Use transformations to visualize spatial relationships Calculate distances and classify triangles Explore and apply perimeter, area, and volume	Explore and create constructions using software Calculate and compare perimeter, area, and volume	Use relevant geometric vocabulary and properties Classify geometric shapes including polyhedra Justify the logic of constructions Use geometry to describe the physical world	Relate formulas to models Investigate contributions of Pythagoras and Euclid Use geometry to describe physical world	Recognize flips, slides, and turns Use spatial relationships to make comparisons
	Secondary	Predict outcome of transformation of figures Analyze reasonableness of area, perimeter, and volume units Model 3-D objects with 2-D diagrams	Model real situations with figures Formulate problems involving figures or diagrams	Explore computer graphics Use geometric exploration software	Formulate definitions Justify conclusions deductively Make conjectures Use locus in real situations	Use manipulatives Explore real applications Apply coordinate geometry Develop limit concepts	Justify constructions Recognize the deductive nature of geometry

TOPIC STRANDS	CONCEPTUAL THREADS						
	LEVEL	ESTIMATION	PROBLEM SOLVING	TECHNOLOGY	COMMUNICATION	CONNECTIONS	REASONING / LOGIC
DATA ANALYSIS	Elementary	Predict experimental probabilities	Formulate and solve problems that involve collecting and analyzing data Experiment with probability Make predictions	Use a variety of technology to analyze data and represent it graphically	Explain inferences and convincing arguments that are based on data analysis Describe data using graphic representations Read tables and form conclusions	Systematically collect, organize, and interpret data in all disciplines	Explore concepts of probability
	Middle Level	Estimate the probability of events Predict graphic representations of data	Experiment with probability Make predictions Collect, organize, represent, and describe data	Explore and produce graphic representation of data using calculators and computers Calculate, analyze, and measure central tendency (mean, median, mode, range)	Describe data using graphic representations Read tables and form conclusions Record and present relationships and results of data analysis	Systematically collect, organize, interpret, and explore data in all disciplines Determine implications and consequences of the displayed data	Investigate concepts of probability Verify and interpret data Explore concepts of randomness
	Secondary	Interpret graphs Use curve fitting to predict from data Use simulations to estimate probabilities	Use sampling techniques Create a data analysis project Use the normal curve to answer questions about data	Use graphic utilities to make graphs, plots, and lines of regression Use calculators or software to evaluate central tendency, dispersion, and relationships of data Use computer network to gather research data Generate random data	Use data to justify a position Be discerning about the use of data analysis to make decisions	Analyze data from other disciplines to support a hypothesis Apply binomial theorems and binomial distributions to real situations	Analyze the effects of data transformations on measures of central tendency and variability

TOPIC STRANDS	CONCEPTUAL THREADS						
	LEVEL	ESTIMATION	PROBLEM SOLVING	TECHNOLOGY	COMMUNICATION	CONNECTIONS	REASONING / LOGIC
PATTERNS & FUNCTIONS	Elementary	Analyze patterns	Represent and solve problems Apply Venn diagrams to objects and groups	Explore patterns	Describe relationships Investigate using graphs	Recognize and describe patterns found in the world Explore patterns in art and other disciplines Explore use of tessellations	Investigate patterns Explore Venn diagrams
	Middle Level	Formulate and test hypotheses	Apply Venn diagrams to objects and groups for classification Create tables of values to determine patterns Develop efficient networking schemes to solve problems	Use graphic utilities and numeric processing software to verify function values and investigate patterns	Investigate relationships between functions and their graphs Describe functions and patterns Recognize and describe patterns found in the world	Explore use and formation of tessellations Explore functions and patterns in art and other disciplines Explore networks in other disciplines	Interpret Venn diagrams Discover and develop formulas
	Secondary	Explore end behavior of functions Sketch graphs of functions Apply interpolation and extrapolation	Recognize similar functions and patterns and apply in different applications Explore restrictions on domain and range in models Use patterns to model complex problems	Use graphics utilities and numeric processing software to analyze the behavior of functions, sequences, and series	Identify patterns and functions Summarize relationships between functions and situations	Model real situations Relate functions to applications	Generalize inductive exploration Recognize mathematics as patterns Apply function properties

TOPIC STRANDS	CONCEPTUAL THREADS						
	LEVEL	ESTIMATION	PROBLEM SOLVING	TECHNOLOGY	COMMUNICATION	CONNECTIONS	REASONING / LOGIC
ALGEBRAIC TOPICS	Elementary	Estimate expressions using manipulatives	Solve for an unknown value using manipulatives	Use a variety of technology to explore variables	Relate manipulatives to symbols	Use real objects as variables	Explore variation in real objects and expressions
	Middle Level	Check reasonableness of solutions	Solve basic linear equations from practical applications Solve systems of equations by graphing Perform polynomial operations with manipulatives	Use appropriate tools to show relationships between quantities Verify results of substituting variables	Discuss relationships between quantities (time vs. speed) Use proper symbols and terminology	Determine relationships between quantities (direct vs. inverse)	Apply inequalities Explore multiple solutions
	Secondary	Use graphic solutions of systems Verify reasonableness of solutions	Model real situations using algebraic expressions and statements Explore open-ended problem situations	Use graphing utilities, and symbolic and numeric solvers to create and explore models	Justify solutions using a variety of methods Use appropriate algebraic terminology	Relate manipulatives and abstraction Use algebra in exploration of other disciplines Display hierarchy of number systems	Inductively develop properties Apply axiomatic nature of algebra

TOPIC STRANDS	LEVEL	CONCEPTUAL THREADS: ESTIMATION	PROBLEM SOLVING	TECHNOLOGY	COMMUNICATION	CONNECTIONS	REASONING / LOGIC
DISCRETE MATHEMATICS	Elementary & Middle Levels	Foundations are laid for many discrete topics in the elementary and middle levels. These topics include probability, functions, patterns, sets, and networks.					
	Secondary	Verify reasonableness of solutions	Develop and analyze algorithms Solve enumeration and finite probability problems	Use computers and graphing calculators	Use matrices and graphs to report results Justify results dependent on related factors Model practical applications	Represent and analyze finite graphs using matrices Discover matrix applications	Apply mathematical induction Analyze feasibility of solutions in context
ADVANCED TOPICS	Middle Level	Foundations are laid for many advanced topics in the middle level. These topics include, but are not limited to, right angle trigonometry (sine, cosine, tangent) and graphing calculators.					
	Secondary	Apply numerical integration (Simpson's Rule, trapezoidal rule)	Determine maximum and minimum points of a graph and interpret the results in problem situations	Recognize the capabilities and limitations of present technology Analyze the behavior of functions using graphs	Justify procedures appropriately	Illustrate relationships between trigonometric functions and polar coordinates, complex numbers, and series Justify hierarchy of number systems Explore applications in business, science, and other areas	Compare the similarities of mathematical systems (bases) Examine the limit process